

Institute of Human Origins

2020 Research Review

Dear Friend of the Institute of Human Origins,

It is no understatement to say that 2020 has been a challenging year! Where IHO researchers and students would have spent many weeks and months at field sites all over the globe, we found ourselves teaching by Zoom or in social-distanced classrooms, and also having time for a deep dive into discoveries and data from past field seasons.

And along with everyone else in the world, we grieve the human losses but **cheer the scientists and medical specialists** who have worked tirelessly to heal those affected and create vaccines in record time.

It is **our uniquely human drive to cooperate** that is breaking through borders and ideologies to end this global scourge. How we evolved these cooperative traits is inherently part of understanding how we “became human.” That question is deeply engrained in IHO research, as you will read about inside this update.

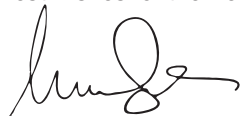
Although we understand the financial challenges that the pandemic has wrought on the global community, **we are grateful to all of you who have helped support IHO's programs** this year. We hope that you will continue to support IHO's mission to connect the human past to our global future.

By the time the 2021 year-end research review is in your hands, IHO will be in its new building—Interdisciplinary Science and Technology Building 7—funded generously by ASU resources. IHO's inclusion in this high-profile building reflects ASU's ongoing support of IHO's groundbreaking research and discoveries about the human story. More than ever though, **IHO relies on the generosity of donors whose passion for the study of human origins** creates the strong “public/private partnership” that we enjoy with the university.

Please consider the opportunities for expanded public outreach, scholarships for students, and seed money for cutting-edge research that your end-of-year investment will provide. And then **join the quest for exploration and discovery of our origins** by supporting IHO with your generous charitable gift. Enclosed you will find the Gift/Pledge form for your convenience. Or you can go to IHO's secure giving website at <https://asufoundation.org/IHO>.

I thank you in advance for your support and look forward to hearing from you. Together we can advance our understanding of our origins!

Best wishes for the New Year,



William H. Kimbel PhD

Director

Virginia M. Ullman Professor of Natural History and the Environment

Virtual reconstruction of the Dikiki skull from CT scans, frontal view. Philippe Gunz image.



Early fossil and archaeological records

Brains do not fossilize, but as the brain grows, the tissues surrounding its outer layer leave an imprint on the inner surface of the bony braincase.

Using CT-scanning technology, brain imprints in fossil skulls of the species *Australopithecus afarensis* (famous for “Lucy” and the “Dikika child” from Ethiopia) shed new light on the evolution of brain growth and organization. Bill Kimbel worked with colleagues for several years to painstakingly reconstruct two fossil skulls of *A. afarensis* juveniles and count dental growth lines to yield exceptionally preserved brain imprints and a precise age at death. The resulting analysis suggests that while *A. afarensis* had an apelike brain structure, it had a prolonged period of brain growth, a humanlike trait.

The Ledi-Geraru research team, led by Kaye Reed and Chris Campisano, returned to the U.S. from the field in Ethiopia just before the lockdown in March. **The team had been excavating not only a large, fossil elephant at an archaeological site, but also recovered a new hominin skull, both of which they will return to analyze as soon as possible.** In lockdown, Reed's Modern and Fossil African Communities Paleoeology Lab compiled databases of 205 modern and 150 fossil localities, the large mammals that inhabit them, and climate parameters for modern and proxy data for fossil sites to reconstruct the ancient ecology. Reed is currently analyzing *Australopithecus afarensis* environmental differences through time and across space, as well as *Paranthropus* species biogeography with these new data.

Curtis Marean and colleagues discovered microscopic shards (cryptotephra) from the Mount Toba (Indonesia) super-volcano in the sediments of site PP5-6 at Pinnacle Point, South Africa, and the near-by open-air site of Vleesbaai. The research analysis showed conclusively that on this coast, modern humans survived what is widely thought to have been a long severe volcanic winter, a climate crisis that some scientists argued nearly caused the extinction of modern humans 75,000 years ago. Along with Chris Campisano, graduate student Jayde Hirniak, and colleagues at University of Nevada, Las Vegas, a **cryptotephra preparation lab has been established at ASU** processing samples from archaeological sites in search of tephra from the Toba supereruption. They are planning to expand this project significantly in coordination with IHO's move into ISTB7.

Chris Campisano and colleagues from the U.S. and India have been working at a field site in the Siwaliks of northern India exploring 11- to 14-million-year-old sediments. A serendipitous discovery of a fossil tooth led to what is the **earliest known fossil of the gibbon lineage**, pushing the first appearance of this family from around 8 million years ago to 13 million years ago. Former IHO postdoctoral researcher Alejandra Ortiz, who is now at New York University, is a member of the research team that analyzed and identified the species.

Although field sites are inaccessible due to the pandemic, the collaborative work of the **African Rift Valley Research Consortium (ARVRC) has continued with the establishment of a consortium-wide database on fossil and archaeological discoveries** by the 100-member, international project. When launched, this database, known as PaleoCore, will be the first-ever data resource shared among independent field projects working in the Rift Valley and will be the basis for the development of research collaborations across the Rift. Bill Kimbel, Kaye Reed, and Chris Campisano are members of the ARVRC.



Emergence of modern humans in Africa

The product of a ten-year effort, Curtis Marean's research group, including research scientist Kerstin Braun, published a special 21-article issue of *Quaternary Science Reviews* that **used their new paleoscape approach to reconstruct the paleoecology of the now submerged offshore platform off the coast of southern Africa.** The Palaeo-Agulhas Plain, a piece of continental shelf the size of Ireland that was repeatedly exposed and submerged as sea levels changed through the Pleistocene. Scientists have long recognized that the plain was an important part of the glacial landscapes and, as the preferred foraging habitat for the early modern humans



Chris Campisano searches the terrain for more fossils from a serendipitous discovery of a gibbon tooth in Ramnagar, India. Christopher Gilbert image.

that inhabited those now coastal sites, one that shaped human populations in southern Africa. The environment and ecology of the plain have been largely unknown, but that is changing as researchers apply advanced methods and reveal archaeological and geological records that tell tales of feast, famine, and migration as the coastline advanced and retreated over many millennia.

Excavations by an international and interdisciplinary collaboration of scientists, led by Erich Fisher, continue at the Mpondoland coastal rock shelter site known as Waterfall Bluff on the south coast of South Africa. In this remote and largely unstudied location, **researchers have used cutting-edge techniques to reconstruct what life was like during glacial and interglacial phases of the Quaternary period and how people survived it.** Their excavations have uncovered evidence of coastal adaptations, diets, and mobility of hunter-gatherers from the end of the last ice age, approximately 35,000 years ago, through the complex transition to the modern time, known as the Holocene. This year, the team published a series of free worksheets about archaeological science topics for a nationwide K-12 education network in South Africa that promotes STEM education to historically underprivileged communities.

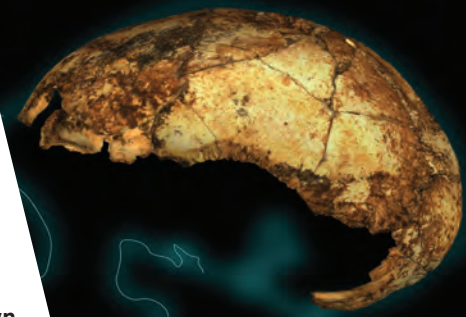
Although researchers have not been able to travel to field sites, in October, **Kathryn Ranhorn organized a virtual trip to her site at Kisesee II in Tanzania.** Two Tanzanian students traveled to the village where the field site is located and completed a ten-day visit. They met with elected officials to work out building plans for both a school and for site protection. The students hosted an open community meeting and spoke on behalf of the Kisesee II archaeology project. Project researchers from around the world made prerecorded videos for community members to watch, and Ranhorn joined the meeting by phone. The good news was that the village has thus far been mostly unaffected by COVID-19, and the site and field house remain in good condition.



Life history and adaptation

Gary Schwartz is part of a multidisciplinary, international team working at an excavation site at Drimolen, South Africa, where the recovery of several new, complete fossils of early hominins are rewriting the story of human origins. The first is the **earliest known skull of *Homo erectus* dated at two million years old**, which is the first of our ancestors to be nearly human-like in their anatomy and aspects of their behavior. Significantly, two other early ancestors were living close-by during the same two-million-year-old time frame—*Paranthropus robustus*, discovered at several nearby cave sites, and *Australopithecus sediba*, found in deposits only several kilometers away from the Drimolen site. Researchers do not yet know if the three species interacted directly, but their presence raises the possibility that these ancient human relatives evolved strategies to divvy up the landscape and its resources in some way to enable them to live in such close proximity.

A remarkably complete *Paranthropus robustus* fossil skull was also discovered at Drimolen and shows that this species evolved rapidly during a turbulent period of local climate change. The new specimen is clearly a male as it is larger than a previously discovered, well-studied member of the species at Drimolen—an individual presumed to be female. The new skull is smaller and differs in important ways from other male *P. robustus* previously discovered at the nearby younger site of Swartkrans—where most of the fossils of this species have been found. Animal fossils preserved in the cave suggest a period of rapid climate change to becoming more arid and cooler forcing *P. robustus* to survive on hard, tough, difficult-to-process foods. When compared to specimens from Swartkrans, the Drimolen cranium very clearly shows that it was less well adapted to eating these challenging menu items. The Drimolen discovery provides a rarely seen window into how changes in environment altered the anatomy of the feeding apparatus in this one species over only 200,000 years—a geological blink of the eye.

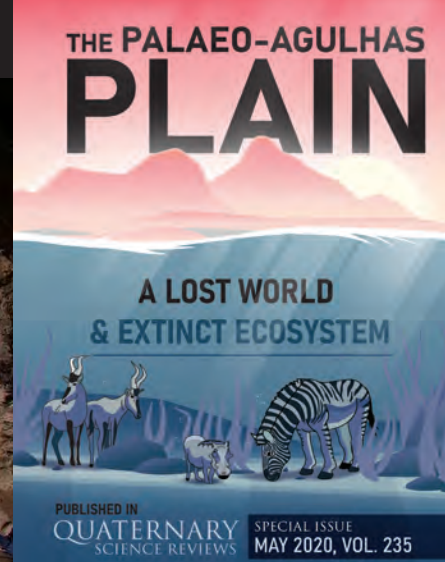


The skull of DNH 134—a *Homo erectus* fossil found at Drimolen. Andy Herries, Jesse Martin, and Renaud Joannes-Boyou image.



Above: A member of Kathryn Ranhorn's team meets with local community members to demonstrate excavation methods. Kathryn Ranhorn image.

Below: Two views from a cave opening on the South African coast—200,000 years ago when lowered sea levels during glacial phases expose the vast Palaeo-Agulhas Plain, and today, covered by the Indian Ocean. Erich Fisher image. Far right: Cover of special issue for *Marean* research. Patrick Fahey image.





Cooperation and cognition

It may not always seem so, but scientists are convinced that humans are unusually cooperative. Sarah Mathew, along with postdoctoral researcher Carla Handley, are **trying to understand why humans are super-cooperators of the animal kingdom.** The answer is thought to be some combination of traits that are exaggerated in humans compared to other animals—language, intelligence, culture, or our very needy children. Teasing apart how these traits influenced the evolution of cooperation has been challenging. Through field studies among multiple pastoralist communities in Kenya who raid each other for cattle and pastures, Mathew and Handley are showing how culturally different groups compete, causing the spread of traits that give groups a competitive edge. People have the general intuition that being cultural helps us cooperate. Their work specifies how this happens: culture allows groups to be different and, therefore, to compete. It is this group competition—ironically—that sculpted our cooperativity.

One of the unique abilities of humans is our regular cooperation with large groups of unrelated individuals and our willingness to punish people who violate social norms—cooperation and punishment are tightly linked. Humans willingly incur costs to punish selfishness in others, and our societies are likely more cooperative as a result. Across six diverse societies around the world, Joan Silk and colleagues **found similarities in how third-party punishment develops and is influenced by social norms, providing evidence for a universal human norm psychology.** The cross-cultural experimental study explored third-party punishment and the impact of the emergence of punishment in children ages 4 to 14. The researchers found that children's prior knowledge of local norms played an important role in explaining societal variation in the development of punishment and prosociality.

Kim Hill and his team have been collecting data from a coastal village of Samal people in Mindanao, Philippines. The project documents interhousehold cooperation inspired by the fact that cooperation is one of the unique features that sets humans apart from other apes. While previous studies in small-scale societies have focused on food sharing, **this study focuses on the entire suite of material goods transfers—food, tools, medicine, clothing, adornments—and services performed across households—childcare, manufacture and repair, cleaning, cooking.** The research first examines what types of households give more, and receive more, from others. The second set of questions looks at relationships between givers and receivers (for example, kinship, reciprocity, differences in need, and proximity).

Have you ever questioned why certain steps are part of a process? Rob Boyd and colleagues looked at why people (but not chimpanzees!) readily imitate and retain “irrelevant” actions. Experiments with “WEIRD”—western, educated, industrial, rich, democratic—participants show that given a complex sequence of actions to open a box and gain a “prize,” **people will imitate every task, even if they appear to be irrelevant actions.** Other experiments show that people imitate everything, but chimpanzees only the causally sensible behaviors. The researchers hypothesize that people imitate irrelevant actions because our psychology has evolved to learn complex tasks that we don't understand and that people want to please the experimenter.

Cumulative cultural evolution (CCE)—the process through which we build upon knowledge inherited over time—has allowed humans to achieve astounding ecological success. Multiple factors are argued to be integral to this process including cooperation, social learning, population size, and connectedness. However, precisely how CCE works remains unclear, as do the reasons why it is effectively unique to our species. Tom Morgan and postdoctoral researcher Elena Miu used a simulation to **examine the role of human**



Above left (two images): The Mindanao village huts sit on stilts over the water. Two students make observations about the exchange of goods from the day's fishing. Kim Hill images.

Left: Carla Handley (center) meeting with Turkana community members. Carla Handley image.

Right: Rob Boyd and Joan Silk published the 9th edition of the “gold standard” text for biological anthropology—*How Humans Evolved*. This edition features a new contribution by Kevin Langergraber on ancient and contemporary DNA research.

Robert Boyd
Joan B. Silk

**HOW
HUMANS
EVOLVED**

9TH EDITION



cognition in cultural adaptation, asking whether CCE is driven by individuals using their intelligence to grapple with the problems they face or “dumber” processes in which individuals copy successful people without trying to understand the problem. Unexpectedly, they found that cultural adaptation is most effective when people are highly intelligent, but rely almost exclusively on “dumber” processes. Nonetheless, the occasional use of individual intelligence is critical to the long-term success of the population.



Genetic inquiry

Ancient Denisovan mitochondrial DNA was recovered in sediments from Baishiya Karst Cave, a limestone cave at the northeast margin of the Tibetan Plateau, 3,280 meters above sea level. Samples of sediments were analyzed by an international team including Charles Perreault. **Denisovan mitochondrial DNA was recovered that has been dated from around 100,000 to 60,000 years ago, and also possibly as recently as 45,000.** If true, this last date may overlap with the presence of modern humans in northeast central Asia. This discovery in Baishiya Karst Cave is the first time Denisovan DNA has been recovered from a location that is outside Denisova Cave in Siberia, Russia—previously the single location in the world where a handful of DNA-bearing Denisovan fossil bones had been discovered. Evidence of this new species has forced anthropologists to revise their model of human evolution outside of Africa.

Dental plaque—the stuff that your hygienist is always scraping off your teeth—holds a treasure trove of your DNA and, if not cleaned off occasionally, will build up and remain on your teeth long after you are gone. This is why dental plaque is a rich source of ancient DNA in the archaeological record and has been used to answer many biological and anthropological questions about Neanderthal diet and behavior and patterns of ancient human migration. In a study led by Anne Stone, including Ian Gilby, **researchers were**

able to assemble a full genome of a common pathogenic bacteria, *P. gingivalis*, from a single chimpanzee. They found that there are core differences between chimpanzee and human oral bacteria, but it is not clear if the differences are a result of diet, geography, host genomes, or other unknown factors. This analysis is significant because no other research projects have focused on great ape oral ecosystems using dental calculus.

The ability to generate **genomic data from wild animal populations has the potential to give unprecedented insight into the population history and dynamics of species in their natural habitats.** However, for many species, it is impossible—legally, ethically, or logistically—to obtain tissue samples of quality sufficient for genomic analyses. A collaboration by Anne Stone, Melissa Wilson, and Ian Gilby evaluated the success of multiple sources of genetic material (feces, urine, dentin, and dental calculus) and several other genomic capture methods in generating genome-scale data in wild eastern chimpanzees from Gombe National Park, Tanzania. The research team, including former postdoctoral researchers Andrew Ozga and Tim Webster, found that urine harbors significantly more host DNA than other sources and highlights urine as a promising and untapped source of DNA that can be noninvasively collected from wild populations of many species.

For links to research articles from IHO researchers, go to <https://iho.asu.edu/publications/articles>

Right: Chimpanzee from the study population at Gombe National Park, Tanzania. Ian Gilby image.

Below left: Chimpanzee tooth showing dental calculus rich in DNA.

Below right: Opening to the Baishiya Karst Cave, where Denisovan DNA was found in sediments. Dongju Zhang image.





Nonhuman primates

Strong social ties are a key driver of cooperation in many species and are associated with adaptive benefits in several of them, including humans, feral horses and dolphins. Although such bonds are widely observed, it is not always known why any two particular animals become “friends.” Ian Gilby and graduate student Joel Bray **used long-term observational studies of chimpanzees at Gombe National Park in Tanzania to analyze what factors explain partner choice and cooperation in male chimpanzees.** They found that male chimpanzees formed friendships lasting up to 13 years. Maternal brothers formed the strongest bonds, but overall, only a small number of close bonds among adult male chimpanzees were explained by kinship. Understanding chimpanzee friendship gives us insight into the evolution of cooperation and friendship in humans, and how cooperation evolves in the absence of factors such as kinship.

In human evolution, behavior is often difficult to study via the fossil record alone. So, studies of nonhuman primates can provide a comparative insight into the potential selection pressures that may have been significant in our own past. An international team of researchers, including Kevin Langergraber, compiled data from fieldwork conducted at 46 field sites, plus an in-depth literature search on chimpanzee research. For 144 chimpanzee social groups, they investigated a long-standing question of under which environmental conditions chimpanzees acquire more behavioral traits and whether chimpanzee groups were more likely to possess a larger set of behaviors if they lived in more seasonal habitats or habitats where forest cover repeatedly changed over the last thousands of years. They found that both recent and historical sources of **environmental variability were positively associated with chimpanzee behavioral and cultural diversity.** These results suggest that a species closely related to humans also uses behavioral flexibility to adapt to more seasonal and unpredictable environments. Since the examined behaviors are largely considered cultural, researchers could further infer that environmental variability also supports cultural diversification in chimpanzees.

Left: Gombe National Park in Tanzania can be lush and green in the rainy season, but turn yellow and dry other parts of the year. Researchers are finding that environmental variability may affect chimpanzee group culture and behavior. Ian Gilby image.

Below: Researchers have observed that some male chimpanzees form friendships in the absence of factors like kinship. Samantha Russak image.



Science Outreach



Join the mission!

The NASA Lucy Mission to the Jupiter Trojan asteroids was named by a Southwest Research Institute (SWRI) team in honor of “Lucy”—the 3.2-million-year-old human ancestor fossil discovered by Don Johanson.

The Lucy Mission will be the first space mission to explore a group of small asteroids known as the Trojan asteroids. These asteroid groups orbit the sun in the same path as Jupiter and provide a unique, never-before-explored sample of the remnants of our early solar system. Just as the Lucy fossil provided unique insights into humanity’s evolution, the Lucy Mission promises to revolutionize our knowledge of planetary origins and the formation of the solar system.

We want to engage middle and high school students and teachers in a contest connecting the human ancestor “Lucy” and the exploration the Trojan Asteroids—or “fossils of the solar system”—so that students will explore a connection between the science of our origins and our place in the solar system.

To hear more about the mission and the contest, join Don Johanson and lead Lucy Mission scientist Hal Levison online with a **National Science Teaching Association “Science Update”** on January 14. Register at the NSTA website link <https://bit.ly/37Fxc95>. You will need to register for a free account to sign up for this online session.

To enter the contest, go to <https://LucyInSpace.asu.edu>.

The prize? A (virtual) visit to your school by Johanson and Levison and an invitation to see the launch of the Lucy Mission at Cape Canaveral, Florida! (The winner must pay for their own travel and expenses to Florida.) We encourage teachers to engage their entire class in the contest.

Contact Julie Russ (jruss@asu.edu) for questions.

It’s all about the Zoom!

When the need to move classes online happened in March, **ASU was ready!** From Friday afternoon to Monday morning, students and faculty went from in-class instruction to ASU Sync via Zoom and online resources in the span of one weekend.

And **IHO quickly followed suit!** Don Johanson has been online with middle and high school students from New York to California, engaging them with the story of Lucy’s discovery and the thrill of exploration at field sites around the world. Johanson and Kaye Reed have **lectured online to American Museum of Natural History** docents.

Several faculty members have done online interviews about their research, and research scientist Erich Fisher’s excavations in South Africa were featured in an episode of the **Discovery Channel’s Expeditions Unknown!** Look for links to these videos at iho.asu.edu/media.

Through the education outreach efforts of ASU for You (ASUforYou.asu.edu), activity on the AskAnAnthropologist.asu.edu and AskABiologist.asu.edu websites increased as parents and teachers look for science resources for students in STEM engagement (check out the Activities list and articles about paleoanthropology!).



Travel and Learn

with the Institute of Human Origins

Travel is on the horizon! We are all ready to break out of our homes and explore the world again. IHO is planning several trips for 2022 and 2023.

- A visit to the Bordeaux region of France to explore ancient caves, including the latest Lascaux reconstructions and 25,000-year-old cave and rock shelter art
- A “Cradle of Civilization” luxury safari to Tanzania, Kenya, and Olduvai Gorge

- A South Africa “Ancient Lives and Landscapes” tour that includes beautiful scenery, complicated history, and discovery sites of early modern humans

If any of these trips sound inviting, email Julie Russ at jruss@asu.edu to get on the waiting list and hear more details about dates and pricing.

During the past year, three IHO-affiliated students received their PhDs


Paige Madison
Advised by Jane Maienschein and William Kimbel
Dissertation: Discovering human origins: Fossils and controversies


Amanda McGrosky
Advised by Gary Schwartz
Dissertation: Hard tissue and environmental correlates of primate growth rate variation


Chalachew Seyoum
Advised by William Kimbel and Kaye Reed
Dissertation: Hominin dietary niche breadth expansion during Pliocene environmental change in eastern Africa


Learn more about IHO and get involved!

Stay in touch for breaking science, news, and events by following IHO on Instagram, Facebook, YouTube, and Twitter.

 Lucy and ASU Institute of Human Origins


 @humanoriginsASU

 [youtube.com/user/LucyASUIHO](https://www.youtube.com/user/LucyASUIHO)

 @human_origins_asu

And don't forget about visiting IHO's website for school-aged students—Ask An Anthropologist—and connect with the Facebook page for “Dr. Anthropology”!

 askananthropologist.asu.edu

 [facebook.com/dranthropology](https://www.facebook.com/dranthropology)

Contact

William Kimbel, Director
Institute of Human Origins
wkimbel.iho@asu.edu
480.727.6580

Julie Russ, Assistant Director
Communications, External Relations
jruss@asu.edu
480.727.6571

Don't miss any announcements, discoveries, or IHO outreach events in our latest e-newsletter. To make sure that you keep abreast of IHO research as it occurs, please update your email contact information online. iho.asu.edu/subscribe

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